

<p style="text-align: center;">CMC CAT GUIDELINES</p> <p style="text-align: center;">FOR</p> <p style="text-align: center;">EXPERIMENT SAFETY REVIEW</p>

INTRODUCTION

This guideline describes how the CMC CAT will ensure that the experiments conducted at its beamlines and in its LOM space by CMC CAT personnel, their collaborators and independent investigators do not present unacceptable risk.

This experiment safety review process is an example of how CMC CAT has integrated safety into the way it manages its activities at the Advanced Photon Source. The process addresses the core functions of the Integrated Safety Management (ISM) system required at Argonne National Laboratory. In the context of experiment safety review, those functions can be described as:

1. Defining planned experiments,
2. Identifying and analyzing hazards associated with planned experiments,
3. Defining safety envelopes by selecting, specifying, and authorizing required hazard controls,
4. Performing experiments within the defined bounds of safety envelopes, and
5. Evaluating the safety performance of completed experiments to provide continuous feedback for improving safety.

The CMC CAT will use the APS Experiment Safety Approval Form (ESAF) to document the experiment safety reviews it conducts. An ESAF is attached to this guideline.

The CMC CAT management assumes full responsibility for all the program elements listed above, including the maintenance of auditable records of the process. The CMC CAT management will make records available to personnel engaged in the Independent CAT Safety Assessment process established and overseen by the APS, to representatives of the APS, and to other ANL and DOE personnel that are required to have access. Moreover, before adding to or changing the safety envelopes described in this plan, CMC CAT management will seek assistance from qualified safety personnel from the APS and ANL.

EXPERIMENT SAFETY REVIEW

DEFINITIONS

The following definitions, derived from the *ANL Environment, Safety and Health Manual* chapter covering experiment safety review:

Experiment. Preparatory non-office activities including the transportation of hazardous materials, experimental activities taking place on the beamline, and subsequent non-office activities taking place at the APS.

Hazard. Any existing or potential¹ condition that, by itself or through interaction with other conditions, has the capacity to cause death, injury, illness, property damage, unacceptable environmental impact, or other losses. In this context, a “condition” means the presence of a material, a piece of equipment or an instrument, an energy source, or an operation. Also see **risk**.

Risk. A quantitative measure (or estimate) of the product of the probability that a hazard will result in that ill effect and the consequence of an ill-effect. (Risk is a measure of the significance of a hazard and an indicator of the need for hazard controls.)

Biohazard. An agent of biological origin that has the capacity to cause deleterious effects in humans. The term includes, but is not necessarily limited to, all infectious microorganisms, their toxins, allergens of biological origin, and genetic fragments.

Flammable. Susceptible to ignition during storage, normal handling or use. (Whether something is flammable has nothing to do with the likelihood that it will ignite. For example, the release of a small quantity of a flammable gas might not result in a gas concentration between the lower and upper flammability limits, but the material would still be considered flammable.) The term includes, but is not necessarily limited to:

- All materials that ignite spontaneously when exposed to air,
- All gases easily ignited in atmospheres containing approximately 21% oxygen,
- All liquids having a flashpoint below 100°F (38°C), and
- All combustible solids and liquids having a physical form that makes them easily ignitable if dispersed into ambient atmospheres.

Radioactive. Having a measurable specific activity above background.

¹The determination of "potential" to cause harm shall be made without considering probability or risk reduction attributable to hazard mitigation measures.

EXPERIMENT SAFETY REVIEW

Toxic: Having the capacity to cause illness or diminished function. (The determination that something is toxic is made without regard to the likelihood that it will actually produce an ill effect. For example, a small quantity of a toxic material might be thought less than the minimum dose needed to cause a toxic effect, but the material would still be considered toxic.) A material that meets one or more of the following criteria should be considered toxic:

- Has a published LD₅₀ (median lethal dose) equal to or less than 0.5 g/kg body weight.
- Has a published LC₅₀ (median lethal concentration) equal to or less than 1000 ppm.
- Has an OSHA permissible exposure limit (PEL) or ACGIH TLV (Threshold Limit Value) equal to or less than 5000 ppm.
- Has an OSHA PEL or ACGIH TLV equal to or less than 10 mg/m³.

GENERAL SAFETY ENVELOPE

All CMC CAT activities will be conducted within an envelope of safety created by engineered hazard controls, formal procedures, training, policy, reviews, authorizations and approvals. The general safety envelope at the APS has been defined by:

1. The User Orientation (provided by the APS)
2. The CMC CAT sector-specific orientation (administered by CMC CAT)
3. The APS Beamline Design Review Process (conducted by the APS)
4. The CMC CAT Management Plan (approved by the APS), including the CMC CAT Safety Plan (which is consistent with *ANL Environment, Safety and Health Manual*)
5. The APS Beamline Commissioning Process (conducted by the APS and CMC CAT)

This CMC CAT experiment review process provides for establishment of safeguards needed to accommodate experiments with hazards not adequately controlled by the processes, policies, and procedures defining the general safety envelope.

EXPERIMENT SAFETY REVIEW

CAT EXPERIMENT APPROVAL AUTHORITY

CMC CAT recognizes that Chapter 21-1 of the *ANL Environment, Safety and Health Manual* limits its experiment approval authority to experiments in the *Everyday Routine*, *Routine Laboratory* and *Nonroutine Laboratory* categories². As specified in the *ANL Environment, Safety and Health Manual*, some activities (e.g., use of Class IV lasers) require additional reviews and approvals by ANL, and CMC CAT will comply with these requirements.

PROCESS OVERVIEW

This guideline describes a process intended to:

- Identify and summarize the hazards associated with performing an experiment,
- Define minimum safety requirements for performing the experiment, and
- Document a decision authorizing the conduct of the experiment.

This guideline calls for the experiment safety review to include:

- Hazard Identification
- Risk Evaluation
- Selection and Specification of (Additional) Hazard Controls
- Approval (with acceptance of residual risk)
- To ensure its effectiveness, the experiment hazard evaluations will be conducted by CMC CAT personnel with a background that will enable them to:

² These categories are defined as follows:

- **Everyday routine** - hazards that are routinely encountered and accepted in the course of everyday living by the vast majority of the general public (e.g., office use, computer use, Class 1 and 2 lasers, auto use, routine custodial services).
- **Routine laboratory** - hazards found in the ANL-E R&D environment that are considered routine and of minimal risk by the scientific community (e.g., Class 3a lasers, routine analytical equipment, electronic calibration equipment, basic machine-shop or craft tools, common solvents, moderate-temperature ovens or heaters).
- **Nonroutine laboratory** - hazards found in the ANL-E R&D environment that involve specialized materials, energy sources, or equipment that might present limited and localized on-site impact and negligible off-site impacts to people or the environment (e.g., Class 3b and 4 lasers, pressurized systems, high voltage electrical systems, radioactivity, chemistry laboratories handling significant quantities of flammable liquids or hazardous chemicals).
-

EXPERIMENT SAFETY REVIEW

- Recognize hazards (as that term is defined above),
- Evaluate their significance,
- Identify required controls, and
- Where control options exist, specify appropriate controls.

CMC CAT reviewers will also attempt to anticipate hazards not well identified by experimenters.

DESCRIPTION OF EXPERIMENTS

CMC CAT will require its members, collaborators and independent investigators to provide detailed written descriptions of the experiments they propose to conduct at CMC CAT's facilities at the APS. The description of the experiment will be provided on or attached to the APS ESAF. The experiment description (and ESAF) may be submitted on paper or electronically.

HAZARD IDENTIFICATION AND ANALYSIS

CMC CAT personnel evaluating safety concerns associated with proposed experiments will attempt to identify hazards associated with the following:

- Materials (including their transport to the APS),
- Equipment, and
- Processes

CMC CAT recognizes that an adequate experiment safety review requires a good understanding of the planned experiment and maybe an iterative process. Consequently, the CAT will advise users that an ESAF containing relevant hazard information in the above three categories must be submitted along with experiment proposals well in advance of beamtime allocation.

Materials

Experimenters planning to use CMC CAT's facilities will provide the following information about each material to be used during the conduct of the experiment:

- Its identity,
- The amount of material to be used, handled, disposed, or transported to/from the APS,
- Its physical form, and
- How it will be handled.

Experimenters will also identify the hazards associated with each material including:

- Toxicity
- Radioactivity

EXPERIMENT SAFETY REVIEW

- Flammability (or other fire hazards)
- Corrosivity
- Incompatibility and unusual reactivity
- Temperature concerns (cryogenic liquids)
- Biological activity

Users will also be asked to alert the CMC CAT to any hazards not listed above.

Equipment

CMC CAT reviewers will attempt to anticipate the hazards associated with experimental apparatus (not a part of the operating beamline) by applying their previous experience, knowledge and intuition. The reviewers will evaluate concerns such as the following:

Utility Requirements

- Electrical
- Water
- Air pressure
- Ventilation

Hazard Categories

- Contains radioactive sources or produces ionizing radiation
- Produces non-ionizing radiation (radiofrequency, microwave) or strong magnetic fields
- Contains laser(s)
- Contains pressurized vessels, vacuum vessels, or pressure cells
- Supplies or uses electrical current with a potential to ground in excess of 50 volts or flowing at a rate in excess of 15 amperes
- Contains capacitors capable of storing dangerous amounts of electricity
- Contains resistive heating devices
- High temperature (accessible surfaces with a temperature exceeding 150°F)
- Moving parts, nip points, and points of operation (motorized, pressure-driven, not manually driven)
- Noise (Emits sound with a sound pressure level of 80 dB(A) as measured at the nearest accessible point during operation.)

EXPERIMENT SAFETY REVIEW

Processes/Operations

Experimenters will attach copies of procedures describing processes and operations they will (or might) perform while working at the CMC CAT's facilities at the APS. The CMC CAT reviewer will review these procedures to verify that they are adequate to control anticipated hazards. Common concerns include:

- Use of lasers
- User of x-ray generators
- Use of hoisting and rigging equipment
 - Weight of object to be lifted?
 - Does object have hoisting eyebolts?
 - Lifting equipment brought by user?
- Chemistry, including chemical reactions and changes in physical form
- Release of contaminants into air or water

The CMC CAT review of the ESAF will address all experimental activities conducted at the APS according to the way the term experiment is defined in Chapter 21-3 of the *ANL Environment, Safety and Health Manual*. CMC CAT personnel will consider both the likelihood that an identified hazard could cause an undesirable event and the consequences of such an event. In addition, CMC CAT will identify whether the APS or ANL has specified mandatory control measures applicable to the hazard. Each identified hazard will then be characterized as to whether or not sufficient controls are in place.

SPECIFICATION OF HAZARD CONTROLS

If the reviewer judges that sufficient controls are not in place, CMC CAT will specify additional controls that must be put in place before the work may begin³. Where possible, CMC CAT will work with the experimenter to ensure the acceptability and feasibility of the controls. In all cases, unless a formally issued variance has been obtained, all APS- and ANL-required hazard controls will be specified.

Each hazard control measure specified during the experiment safety review will be identified on the ESAF,⁴ or on attachments if more space is required.

³ Associated experimental activities that do not create or result in exposure to hazards may be performed before all controls are in place.

⁴ Such specification can be by reference to standard operating procedures, approved safety envelopes, etc.

EXPERIMENT SAFETY REVIEW

USE OF STANDARD EXPERIMENT SAFETY ENVELOPES

An experiment safety envelope is a set of controls, consisting of training requirements, engineered controls, and procedural controls⁵, that is sufficient to provide for the safe conduct of all individual experiments falling into an associated class.

CMC CAT anticipates that many hazards associated with experiments will fall into a few well-defined groups. Consequently, CMC CAT has established a number of hazard classes for which it has formulated corresponding *safety envelopes*. Individual experiments that appear to fall into such pre-approved classes will only be evaluated to the extent necessary to establish that they do not exceed the evaluated hazard levels and that they do not introduce other hazards not considered with the class that was evaluated. An attachment to this guideline describes the standard safety envelopes defined by CMC CAT.

Before an approved experiment is modified, it will be reevaluated to ensure that it still falls within the previously specified safety envelope. If the safety envelope might not be adequate to reduce associated risk to acceptable levels, a new hazard class will be assigned and experimental work will not continue/begin until appropriate hazard controls are in place.

VERIFICATION REQUIREMENTS

CMC CAT will require a documented last-minute verification whenever hazard controls cannot be put in place until the last minute. CMC CAT will also require documented verification when specified measures are intended to control substantial risks, that is, those with higher probability or possibly grave consequences. CMC CAT personnel authorizing the experiments will specify on the ESAF who should verify that specified hazard controls are actually in place.

AUTHORIZATION

No experiment may be started until formally authorized by a designated individual. An attachment to this guideline lists those individuals whom the CAT has so designated.

DOCUMENTATION

The CMC CAT will use the completed ESAF, along with attachments as needed to provide adequate detail, to record and retain the results of each experiment safety review. This documentation must include:

- Identification of the experiment,
- Identification of significant hazards,

⁵ For the purpose of this write-up, obtaining reviews, authorizations and approvals will be treated as procedural requirements.

EXPERIMENT SAFETY REVIEW

- Required hazard controls measures,⁶
- Verification requirements,
- A statement accepting residual risk, and
- The name and signature of the person authorizing the performance of the experiment.

DISCLOSURE

The CMC CAT will forward a copy of the completed APS ESAF and relevant supporting documents to the APS Experiment Safety Coordinator when the decision is made to approve the proposed experiment. In addition, CMC CAT will have an APS Floor Coordinator post the original copy of the ESAF and all relevant attachments at the beamline before or at the commencement of the corresponding beamline activities.

FEEDBACK

The CMC CAT will periodically evaluate the effectiveness of this procedure to determine what changes should be implemented to improve the process. To this end, the CMC CAT will participate in the Independent CAT Safety Assessment process established by the APS. In addition, the CMC CAT will consider recommendations made by review committees appointed by member institutions. Moreover, whenever the review process or a specified envelope fails to control a hazard, CMC CAT will immediately investigate to determine the cause of the failure and what should be done to prevent recurrence. As defined elsewhere in its safety plan, CMC CAT will inform the APS about incidents involving the failure of the review process or a specified control.

⁶ I.e., all measures except those that form the basic safety envelope at the APS.

EXPERIMENT SAFETY REVIEW

ATTACHMENTS

- APS Experiment Safety Approval Form
- CMC CAT personnel with Experiment Approval Authority
- Definition of CMC CAT Safety Envelopes

Attachment 1

CMC CAT Personnel with Experiment Approval Authority

As Director of the CMC CAT, I judge the following personnel to be capable of evaluating the residual risk posed by experimental activities after specified controls have been implemented and determining whether the residual risk will be acceptable to this CAT. These personnel have the authority to act for me by approving, from a safety standpoint, proposed experimental activities at the CMC CAT's facilities at the APS.

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.

[Name]

[Date]

[Title]